

WHAT IS CLAIMED IS:

- 1 1. A dispensing tip to be coupled to a resilient-
2 walled vessel, comprising:
3 a valve structured to allow drop-wise dispensing
4 from the vessel when the dispensing tip is coupled to
5 the vessel and sufficient manual pressure is applied to
6 the resilient wall, and to prevent liquid back flow at
7 zero as well as near zero pressure differentials across
8 the valve;
9 at least one vent opening structured to allow air
10 into and out of the vessel when the dispensing tip is
11 coupled to the vessel; and
12 at least one filtration element extending across
13 the at least one vent opening and structured to allow
14 gaseous fluids to pass through the vent opening while
15 blocking liquid fluids and contaminants.
- 1 2. A dispensing tip according to claim 1, further
2 comprising a retaining member structured and positioned
3 to maintain the at least one filtration element in a
4 fixed position.
- 1 3. A dispensing tip according to claim 2, wherein
2 the retaining member defines an at least one aperture
3 alignable with the at least one vent opening.
- 1 4. A dispensing tip according to claim 3, wherein
2 the at least one aperture and the at least one vent
3 opening are sized and placed to allow air flow through
4 both the at least one aperture and the at least one vent

5 opening regardless of the coaxial orientation of the
6 retaining member.

1 5. A dispensing tip according to claim 1, wherein
2 the at least one vent opening comprises a plurality of
3 vent openings substantially symmetrically arranged about
4 the valve.

1 6. A dispensing tip according to claim 5, further
2 comprising a retaining member structured and positioned
3 to maintain the at least one filtration element in a
4 fixed position, the retaining member including a
5 plurality of apertures sized and placed to allow air
6 flow through both the apertures and the vent openings
7 regardless of the coaxial orientation of the retaining
8 member relative the dispensing tip.

1 7. A dispensing tip according to claim 1, wherein
2 the valve comprises a substantially planar surface, at
3 least one slit extending through the substantially
4 planar surface, and a plurality of mutually facing
5 surfaces extending along opposing sides of the at least
6 one slit, the plurality of mutually facing surfaces
7 being structured to exert sufficient force on one
8 another when the valve is closed to prevent microbe-
9 sized particles from passing through the at least one
10 slit when the valve is closed.

1 8. A dispensing tip according to claim 7, wherein
2 the plurality of mutually facing surfaces are structured
3 to exert sufficient force on one another to prevent

4 particles larger than 0.22 micron in diameter from
5 passing through the at least one slit when the valve is
6 closed.

1 9. A dispensing tip according to claim 1, wherein:
2 the vessel defines an interior space; and
3 the dispensing tip further defines an unobstructed
4 bore structured to communicate directly with the
5 interior space when the tip is coupled to the vessel.

1 10. A dispensing tip according to claim 1, which
2 includes:

3 a base portion formed of a first material; and
4 an end portion disposed distally of the base
5 portion;

6 wherein the end portion is formed of a second
7 material more flexible than the first material.

1 11. A dispensing tip according to claim 10,
2 wherein;

3 the first material is selected from the group
4 consisting of polyethylene, polypropylene, polystyrene,
5 polycarbonate, and acrylonitrile-butadiene-styrene
6 polymers, and mixtures thereof; and

7 the second material is selected from the group
8 consisting of silicone polymers, polyisoprene,
9 plasticized polyvinyl chloride, polyurethane, ethylene-
10 butylene copolymers, styrenics, and mixtures thereof.

1 12. A dispensing tip according to claim 10,
2 wherein the valve is formed in the end portion.

1 13. A dispensing tip according to claim 1, further
2 comprising at least one deflector element structured to
3 deflect liquid away from the at least one vent opening.

1 14. A dispensing tip according to claim 13,
2 wherein the at least one deflector element includes an
3 apron structure extending radially outwardly from a
4 central axis of the tip.

1 15. A dispensing tip according to claim 13,
2 wherein the at least one vent opening is located in a
3 plateau formed on a base portion proximal of the valve,
4 and wherein the deflector element comprises at least one
5 channel provided adjacent the plateau for directing
6 liquid away from the at least one vent opening.

1 16. A dispensing tip according to claim 1
2 configured substantially as a truncated cone having a
3 distal end, and wherein the valve comprises a normally
4 closed slit formed in the distal end of the tip.

1 17. A dispensing tip according to claim 1, wherein
2 the valve is a check valve having a cracking pressure
3 greater than 0.1 psi.

1 18. A dispensing tip according to claim 1, wherein
2 the valve is a check valve having a cracking pressure of
3 at least 0.5 psi.

1 19. A dispensing tip according to claim 1, wherein
2 the valve is a check valve having a cracking pressure in
3 the range of 1 to 4.5 psi.

1 20. A dispensing tip according to claim 16 wherein
2 the distal end of the tip has a tip diameter D , and the
3 slit has a length l no greater than about $0.96 D$.

1 21. A dispensing tip according to claim 16 wherein
2 the distal end of the tip is substantially circular.

1 22. A dispensing tip according to claim 16 wherein
2 the slit has a depth d no less than about $0.04D$.

1 23. A dispensing tip according to claim 16
2 wherein:

3 the tip defines a tapered bore extending between
4 the slit and a proximal end of the cone, the bore having
5 a maximum diameter at the proximal end;

6 the tip has a maximum wall thickness t_{MAX} at the
7 proximal end of the cone, where t_{MAX} is no less than
8 about $1.5d$.

1 24. A dispensing tip according to claim 1, wherein
2 the tip comprises an elastomeric material having an
3 elongation of at least about 150%.

1 25. A dispensing tip according to claim 1, wherein
2 the tip comprises an elastomeric material having a tear
3 strength of at least about 150 ppi.

1 26. A dispensing tip according to claim 1, wherein
2 the tip comprises an elastomeric material having a
3 compression strength no greater than about 40%.

1 27. A dispensing tip according to claim 1, wherein
2 the tip comprises an elastomeric material having a Shore
3 A durometer of about 30 to about 80.

1 28. A dispensing assembly to be coupled to a
2 resilient-walled vessel containing a liquid, comprising:
3 a tip defining a bore positioned to be in direct
4 communication with the vessel when coupled to the
5 vessel, the tip including a distal end; and
6 a valve provided at the distal end of the tip, the
7 valve extending substantially coaxially with the bore;
8 wherein the valve is structured to allow drop-wise
9 liquid dispensing from the vessel when the assembly is
10 coupled to the vessel and sufficient manual pressure is
11 applied to the resilient wall of the vessel, and to
12 prevent liquid back flow at zero as well as near zero
13 pressure differentials across the valve.

1 29. A dispensing assembly according to claim 28,
2 further comprising:
3 at least one vent opening structured to allow air
4 into and out of the vessel when the dispensing assembly
5 is coupled to the vessel; and
6 at least one filtration element extending across
7 the at least one vent opening and structured to allow
8 gaseous fluids to pass through the vent opening while
9 blocking liquid fluids and contaminants.

1 30. A dispensing assembly according to claim 29,
2 further comprising a retaining member structured and
3 positioned to maintain the at least one filtration
4 element in a fixed position.

1 31. A dispensing assembly according to claim 30,
2 wherein the retaining member defines at least one
3 aperture alignable with the vent opening.

1 32. A dispensing assembly according to claim 31,
2 wherein the at least one aperture and the at least one
3 vent opening are sized and placed to allow air flow
4 through both the aperture and the vent opening
5 regardless of the coaxial orientation of the retaining
6 member.

1 33. A dispensing assembly according to claim 29,
2 wherein the at least one vent opening comprises a
3 plurality of vent openings substantially symmetrically
4 arranged about the valve.

1 34. A dispensing assembly according to claim 33,
2 further comprising a retaining member structured and
3 positioned to maintain the at least one filtration
4 element in a fixed position, the retaining member
5 including a plurality of apertures sized and placed to
6 allow air flow through both the apertures and the vent
7 openings regardless of the coaxial orientation of the
8 retaining member.

1 35. A dispensing assembly according to claim 28,
2 wherein the valve comprises a distal surface, at least
3 one slit extending through the distal surface and a
4 plurality of mutually facing surfaces extending along
5 opposing sides of the at least one slit, the plurality
6 of mutually facing surfaces being structured to exert
7 sufficient force on one another when the valve is closed
8 to prevent microbe-sized particles from passing through
9 the at least one slit when the valve is closed.

1 36. A dispensing assembly according to claim 35,
2 wherein the plurality of mutually facing surfaces are
3 structured to exert sufficient force on one another to
4 prevent particles larger than 0.22 micron in diameter
5 from passing through the at least one slit when the
6 valve is closed.

1 37. A dispensing assembly according to claim 28
2 wherein the tip comprises:
3 a base portion formed of a first material; and
4 an end portion disposed distally of the base
5 portion;
6 wherein the end portion is formed of a second
7 material more flexible than the first material.

1 38. A dispensing assembly according to claim 37,
2 wherein;
3 the first material is selected from the group
4 consisting of polyethylene, polypropylene, polystyrene,
5 polycarbonate, and acrylonitrile-butadiene-styrene
6 polymers, and mixtures thereof; and

7 the second material is selected from the group
8 consisting of silicone, polyisoprene, plasticized
9 polyvinyl chloride, polyurethane, ethylene-butylene
10 copolymers, and mixtures thereof.

1 39. A dispensing assembly according to claim 37
2 wherein the valve is formed in the end portion.

1 40. A dispensing assembly according to claim 29
2 further comprising at least one deflector element
3 structured to deflect liquid away from the at least one
4 vent opening.

1 41. A dispensing assembly according to claim 40,
2 wherein the at least one deflector element includes an
3 apron structure extending radially outwardly from a
4 central axis of the tip.

1 42. A dispensing assembly according to claim 40,
2 wherein the at least one vent opening is located in a
3 plateau formed on a base portion proximal of the valve,
4 and wherein the deflector element comprises at least one
5 channel provided adjacent the plateau for directing
6 liquid away from the at least one vent opening.

1 43. A dispensing assembly according to claim 28,
2 further comprising:
3 a cap structured to cover the tip when the assembly
4 is not in dispensing use;
5 an anti-microbial liner and in the cap and
6 effective in reducing contamination of the tip.

1 44. A dispensing assembly according to claim 43,
2 wherein the anti-microbial liner comprises:
3 a resilient component structured and adapted to
4 sealingly engage the tip when the cap is positioned
5 thereon; and
6 an antimicrobial component.

1 45. A dispensing assembly according to claim 44
2 where
3 in the anti-microbial component comprises an anti-
4 microbial coating on the resilient component.

1 46. A dispensing assembly according to claim 44,
2 wherein the anti-microbial component is dispersed
3 throughout the resilient component.

1 47. A dispensing assembly according to claim 28,
2 wherein the valve is a check valve having a cracking
3 pressure greater than 0.1 psi.

1 48. A dispensing assembly according to claim 28,
2 wherein the valve is a check valve having a cracking
3 pressure of at least 0.5 psi.

1 49. A dispensing assembly according to claim 28,
2 wherein the valve is a check valve having a cracking
3 pressure in the range of 1 to 4.5 psi.

1 50. A dispensing assembly according to claim 28
2 wherein the tip is configured substantially as a truncated
3 cone having a distal end, and wherein the valve comprises

4 a normally closed slit formed in the distal end of the
5 tip.

1 51. A dispensing assembly according to claim 50
2 wherein the distal end of the tip has a tip diameter D ,
3 and the slit has a length l no greater than about $0.96 D$.

1 52. A dispensing assembly according to claim 50
2 wherein the distal end of the tip is substantially
3 circular.

1 53. A dispensing assembly according to claim 50
2 wherein the slit has a depth d no less than about $0.04D$.

1 54. A dispensing assembly according to claim 50
2 wherein:

3 the tip defines a tapered bore extending between the
4 slit and a proximal end of the cone, the bore having a
5 maximum diameter at the proximal end;

6 the tip has a maximum wall thickness t_{MAX} at the
7 proximal end of the cone, where t_{MAX} is no less than about
8 $1.5d$.

1 55. A dispensing assembly according to claim 28,
2 wherein the tip comprises an elastomeric material having
3 an elongation of at least about 150%.

1 56. A dispensing assembly according to claim 28,
2 wherein the tip comprises an elastomeric material having a
3 tear strength of at least about 150 ppi.

1 57. A dispensing assembly according to claim 28,
2 wherein the tip comprises an elastomeric material having a
3 compression strength no greater than about 40%.

1 58. A dispensing assembly according to claim 28,
2 wherein the tip comprises an elastomeric material having a
3 Shore A durometer of about 30 to about 80.

1 59. A dispensing assembly to be coupled to an
2 opening in a resilient-walled vessel containing a
3 liquid, comprising:

4 a tip defining an unobstructed bore communicating
5 directly with the opening in the vessel, the tip
6 including a distal end; and

7 a valve provided at the distal end of the tip, the
8 valve extending substantially coaxially with the bore
9 and comprising a planar surface, at least one slit
10 extending through the substantially planar surface and a
11 plurality of mutually facing surfaces extending along
12 opposing sides of the at least one slit, the plurality
13 of mutually facing being structured to exert sufficient
14 force on one another when the valve is closed to prevent
15 microbe-sized particles from passing through the at
16 least one slit when the valve is closed.

1 60. A dispensing assembly according to claim 59,
2 further comprising:

3 at least one vent opening structured to allow air
4 into and out of the vessel when the dispensing tip is
5 coupled to the vessel; and

6 at least one filtration element extending across
7 the at least one vent opening and structured to allow
8 gaseous fluids to pass through the vent opening while
9 blocking liquid fluids and contaminants.

1 61. A dispensing assembly according to claim 60,
2 further comprising a retaining member structured and
3 positioned to maintain the at least one filtration
4 element in a fixed position.

1 62. A dispensing assembly according to claim 61,
2 wherein the retaining member defines at least one
3 aperture alignable with the at least one vent opening.

1 63. A dispensing assembly according to claim 62,
2 wherein the at least one aperture and the at least one
3 vent opening are sized and placed to allow air flow
4 through both the at least one aperture and the at least
5 one vent opening regardless of the coaxial orientation
6 of the retaining member.

1 64. A dispensing assembly according to claim 62,
2 wherein the at least one vent opening comprises a
3 plurality of vent openings symmetrically arranged about
4 the valve.

1 65. A dispensing assembly according to claim 64,
2 further comprising a retaining member structured and
3 positioned to maintain the at least one filtration
4 element in a fixed position, the retaining member
5 including a plurality of apertures sized and placed to
6 allow air flow through both the apertures and the vent
7 openings regardless of the coaxial orientation of the
8 retaining member.

1 66. A dispensing assembly according to claim 59,
2 wherein the plurality of mutually contacting surfaces
3 exert sufficient force on one another to prevent
4 particles larger than 0.22 micron in diameter from
5 passing through the at least one slit when the valve is
6 closed.

1 67. A dispensing assembly according to claim 59,
2 wherein the tip comprises:
3 a base portion formed of a first material; and
4 an end portion disposed distally of the base
5 portion;
6 wherein the end portion is formed of a second
7 material more flexible than the first material.

1 68. A dispensing assembly according to claim 67,
2 wherein;
3 the first material is selected from the group
4 consisting of polyethylene, polypropylene, polystyrene,
5 polycarbonate, and acrylonitrile-butadiene-styrene
6 polymers, and mixtures thereof; and
7 the second material is selected from the group
8 consisting of silicone, polyisoprene, plasticized
9 polyvinyl chloride, polyurethane, ethylene-butylene
10 copolymers, and mixtures thereof.

1 69. A dispensing assembly according to claim 67,
2 wherein the valve is formed in the end portion.

1 70. A dispensing assembly according to claim 60,
2 further comprising at least one deflector element

3 structured to deflect liquid away from the at least one
4 vent opening.

1 71. A dispensing assembly according to claim 70,
2 wherein the at least one deflector element includes an
3 apron structure extending radially outwardly from a
4 central axis of the tip.

1 72. A dispensing assembly according to claim 70,
2 wherein the at least one vent opening is located in a
3 plateau formed on a base portion proximal of the valve,
4 and wherein the deflector element comprises at least one
5 channel provided adjacent the plateau for directing
6 liquid away from the at least one vent opening.

1 73. A dispensing assembly according to claim 59,
2 further comprising:
3 a cap structured to cover the tip when the assembly
4 is not in use;
5 an anti-microbial liner located in the cap and
6 effective in reducing contamination of the tip.

1 74. A dispensing assembly according to claim 73,
2 wherein the anti-microbial liner comprises:
3 a resilient component structured and adapted to
4 sealingly engage the tip when the cap is positioned
5 thereon; and
6 an antimicrobial component.

1 75. A dispensing assembly according to claim 74,
2 wherein the anti-microbial component comprises an anti-
3 microbial coating on the resilient component.

1 76. A dispensing assembly according to claim 74,
2 wherein the anti-microbial component is dispersed
3 throughout the resilient component.

1 77. A dispensing assembly according to claim 59,
2 wherein the valve is a check valve having a cracking
3 pressure greater than 0.1 psi.

1 78. A dispensing assembly according to claim 59,
2 wherein the valve is a check valve having a cracking
3 pressure of at least 0.5 psi.

1 79. A dispensing assembly according to claim 59,
2 wherein the valve is a check valve having a cracking
3 pressure in the range of 1 to 4.5 psi.

1 80. A dispensing tip according to claim 59 wherein
2 the tip is configured substantially as a truncated cone
3 having a distal end, and wherein the valve comprises a
4 normally closed slit formed in the distal end of the tip.

1 81. A dispensing tip according to claim 80 wherein
2 the distal end of the tip has a tip diameter D , and the
3 slit has a length l no greater than about $0.96 D$.

1 82. A dispensing tip according to claim 80 wherein
2 the distal end of the tip is substantially circular.

1 83. A dispensing tip according to claim 80 wherein
2 the slit has a depth d no less than about $0.04D$.

1 84. A dispensing tip according to claim 80 wherein:
2 the tip defines a tapered bore extending between the
3 slit and a proximal end of the cone, the bore having a
4 maximum diameter at the proximal end;
5 the tip has a maximum wall thickness t_{MAX} at the
6 proximal end of the cone, where t_{MAX} is no less than about
7 1.5d.

1 85. A dispensing tip according to claim 59, wherein
2 the tip comprises an elastomeric material having an
3 elongation of at least about 150%.

1 86. A dispensing tip according to claim 59, wherein
2 the tip comprises an elastomeric material having a tear
3 strength of at least about 150 ppi.

1 87. A dispensing tip according to claim 59, wherein
2 the tip comprises an elastomeric material having a
3 compression strength no greater than about 40%.

1 88. A dispensing tip according to claim 59, wherein
2 the tip comprises an elastomeric material having a Shore A
3 durometer of about 30 to about 80.

1 89. A dispensing assembly to be coupled to a
2 vessel containing a sterile liquid, comprising:
3 a tip structured to dispense liquid from the
4 vessel;
5 a cap structured to cover the tip when the assembly
6 is not in dispensing use; and
7 an anti-microbial liner located in the cap and
8 effective in reducing contamination of the tip.

1 90. A dispensing assembly according to claim 89,
2 wherein the anti-microbial liner comprises:
3 a resilient component structured and adapted to
4 sealingly engage the tip when the cap is positioned
5 thereon; and
6 an antimicrobial component.

1 91. A dispensing assembly according to claim 90,
2 wherein the anti-microbial component comprises an anti-
3 microbial coating on the resilient component.

1 92. A dispensing assembly according to claim 90
2 wherein the anti-microbial component is dispersed
3 throughout the resilient component.

1 93. A dispensing assembly to be coupled to a
2 vessel containing a liquid, comprising:
3 a dispensing tip including a normally closed valve
4 structured to allow dispensing from the vessel when the
5 dispensing tip is coupled to the vessel and the valve
6 is open;

7 at least one vent opening structured to allow air
8 into and out of the vessel when the dispensing tip is
9 coupled to the vessel;

10 at least one filtration member extending across the
11 at least one vent opening and structured to allow
12 gaseous fluids to pass through the vent opening while
13 blocking liquid fluid and contaminants; and

14 a retaining member structured to maintain the at
15 least one filtration element in a fixed position when
16 juxtaposed therewith, the retaining member defining at
17 least one aperture configured to communicate with the
18 vent opening when the retaining member is juxtaposed

19 with the filtration member, regardless of the rotational
20 orientation of the retaining member relative the
21 dispensing tip.

1 94. A dispensing assembly according to claim 93,
2 wherein the at least one vent opening comprises a
3 plurality of vent openings symmetrically arranged about
4 the valve.

1 95. A dispensing assembly according to claim 93
2 wherein the at least one aperture includes a plurality
3 of apertures sized and placed to allow air flow through
4 both the apertures and the at least one vent openings
5 regardless of the angular orientation of the retaining
6 member relative the dispensing tip.

1 96. A method of dispensing a preservative-free
2 solution comprising the steps of:

3 providing the preservative-free solution in a
4 resilient-walled vessel having a tip defining an
5 unobstructed bore directly communicating with the vessel
6 and a valve provided at the distal end of the tip, the
7 valve being structured to allow drop-wise liquid
8 dispensing from the vessel when sufficient manual
9 pressure is applied to the resilient wall of the vessel,
10 and to prevent liquid backflow at zero as well as near
11 zero pressure differentials across the valve;

12 applying sufficient manual pressure to the
13 resilient wall of the vessel to dispense a single drop
14 of the solution; and

15 immediately thereafter removing the manual pressure
16 to close the valve.

1 97. A method of dispensing a preservative-free
2 solution comprising the steps of:

3 providing the preservative-free solution in a
4 resilient-walled vessel having a tip defining a bore in
5 direct communication with the vessel, the tip including
6 a distal end, and a valve provided at the distal end of
7 the tip, the valve extending substantially coaxially
8 with the bore, wherein the valve is structured to allow
9 drop-wise liquid dispensing from the vessel when the
10 assembly is coupled to the vessel and sufficient manual
11 pressure is applied to the resilient wall of the vessel,
12 and to prevent liquid back flow at zero as well as near
13 zero pressure differentials across the valve;

14 applying sufficient manual pressure to the
15 resilient wall of the vessel to dispense a single drop
16 of the solution; and

17 immediately thereafter removing the manual pressure
18 to close the valve.

1 98. A method of dispensing a preservative-free
2 solution comprising the steps of:

3 providing the preservative-free solution in a
4 resilient-walled vessel having a tip defining a bore in
5 direct communication with the vessel, the tip including
6 a distal end, and a valve provided at the distal end of
7 the tip, the valve extending substantially coaxially
8 with the bore and comprising a planar surface, at least
9 one slit extending through the substantially planar
10 surface and a plurality of mutually facing surfaces
11 extending along opposing sides of the at least one slit,
12 the plurality of mutually facing being structured to
13 exert sufficient force on one another when the valve is
14 closed to prevent microbe-sized particles from passing

15 through the at least one slit when the valve is closed;
16 applying sufficient manual pressure to the
17 resilient wall of the vessel to dispense a single drop
18 of the solution; and
19 immediately thereafter removing the manual pressure
20 to close the valve.

1 99. A dispensing assembly according to claims 7,
2 35 or 59, wherein the slit extends substantially
3 perpendicularly through the surface.

1 100. A dispensing assembly according to claims 16,
2 35, 50 or 80, wherein the truncated cone is
3 substantially gaussian in configuration.

1 101. A dispensing assembly according to claims 16,
2 35, 50 or 80, wherein the distal end is substantially
3 planar.

1 102. A dispensing assembly according to claims 1,
2 28, 59 or 93, which further comprises an antimicrobial
3 component.

1 103. A dispensing assembly according to claim 102,
2 wherein the antimicrobial component is present in an
3 effective amount.

1 104. A dispensing assembly according to claim 102,
2 wherein the antimicrobial component is present as a
3 coating and/or is included within at least one or more
4 portions of the assembly.

1 105. A method according to claims 96, 97, or 98,
2 wherein at least one of the vessel and the tip comprises
3 an antimicrobial component.